

ECOPROPHET

Improved **ECO**system **PRO**ductivity Modeling
by Innovative Algorithms and Remotely Sensed
PHEnology Indicators

Promoters: Prof. Ivan Janssens & Manuela Balzarolo

12 - 13 SEPTEMBER 2019, BRUSSELS (BELGIUM)



ECOPROPHET “Improved Ecosystem Productivity Modeling by Innovative Algorithms and Remotely Sensed Phenology Indicators” is a project funded by BELSPO (Belgian Science Policy Office) in the frame of the STEREO III programme (Contract number: SR/00/334)

Project team



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Alirio ARBOLEDA
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International partner 1
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IP1, PKU

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Zaichun ZHU
Qiang LIU
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International partner 2
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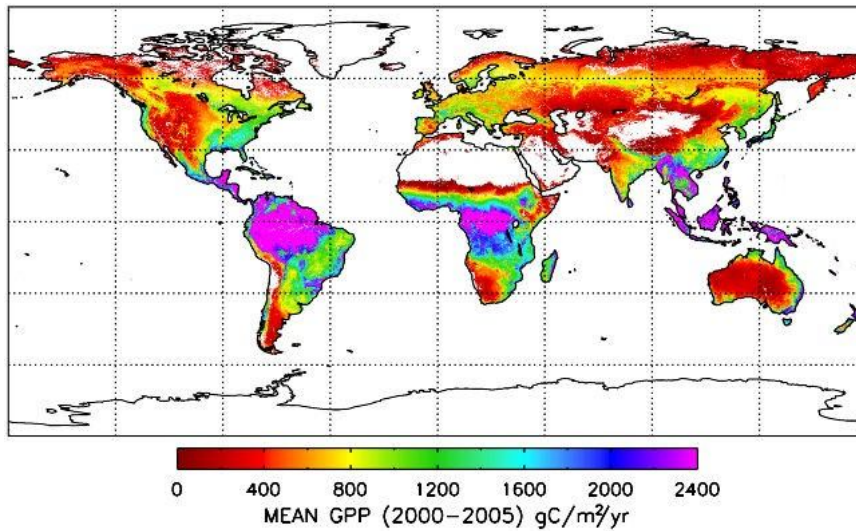
Philippe CIAIS
Ana BASTOS (left for Munich in March 2018)
Fabienne MIGNAN
Xiuzhi CHEN* (back in China in May 2019)
Liyang LIU (PhD, arriving in Oct/Nov 2019)

Motivation

Terrestrial ecosystems provide food, feed, fibre, ...

□ Important to monitor global ecosystem productivity and build better models

□ R:S-based models & Land surface models



MOD17

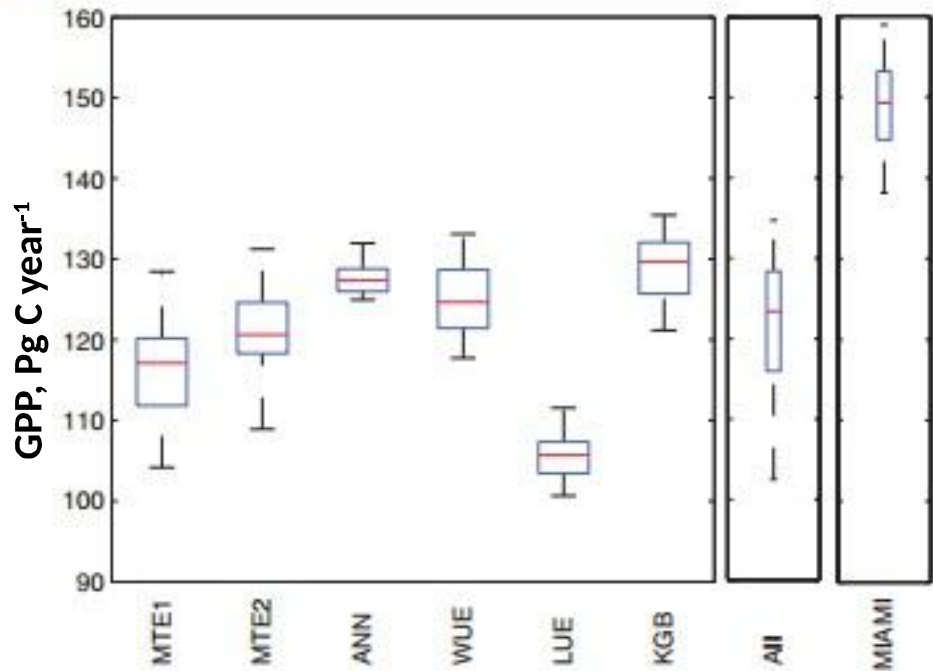
Motivation

Terrestrial ecosystems provide food, feed, fibre, ...

□ Huge uncertainty in global GPP & NPP estimates

GPP:

Beer et al. Science 2010



Motivation

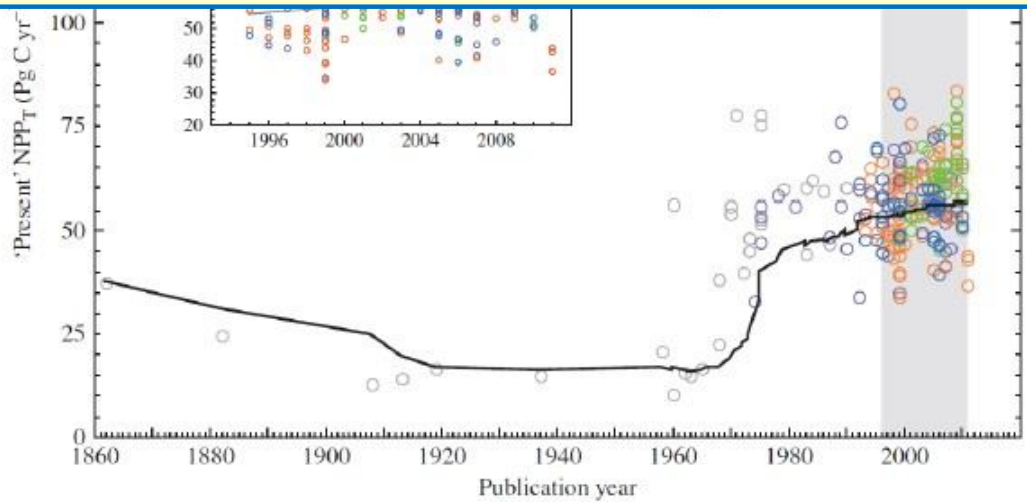
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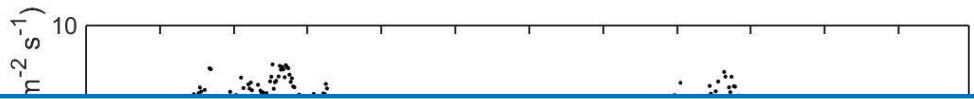
Overall objective of this project = improve estimates and projections of GPP and NPP

NPP:
Ito, GCB 2011



Greening of the Earth

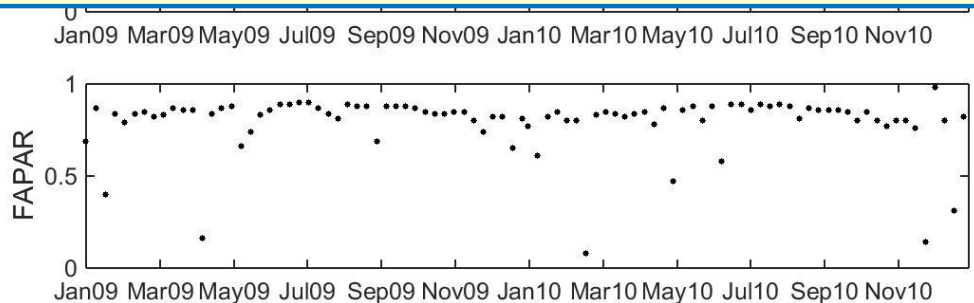
e.g. Mediterranean oak forest



Resolve this issue by no longer depending on NDVI

□ Use new RS products that correlate with plant functioning, not with canopy greenness

Reports 2016



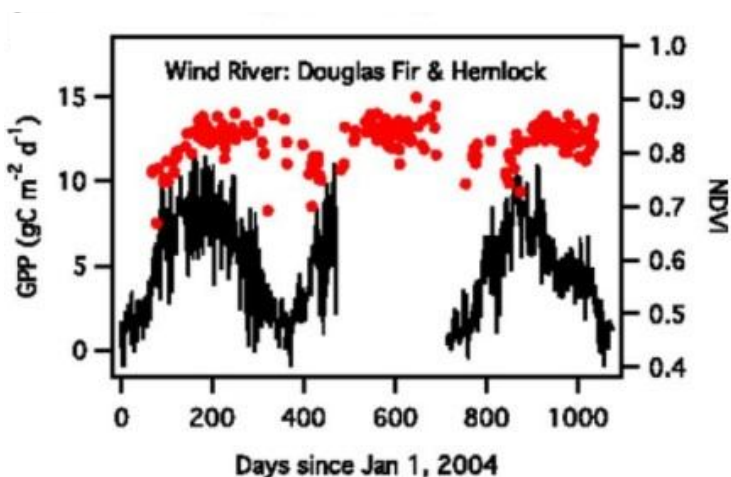
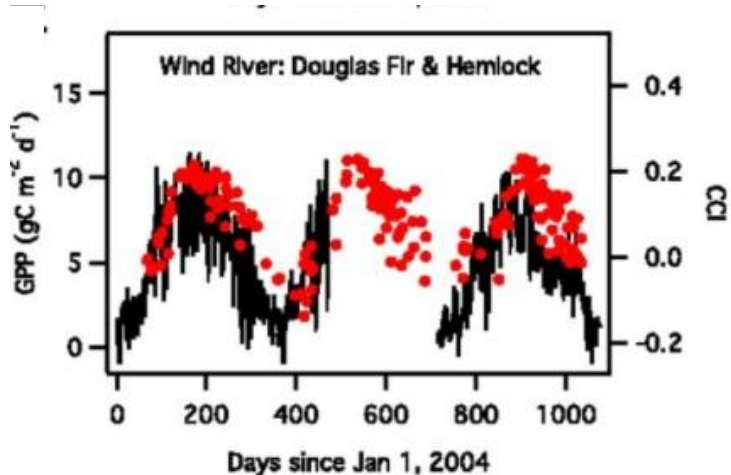
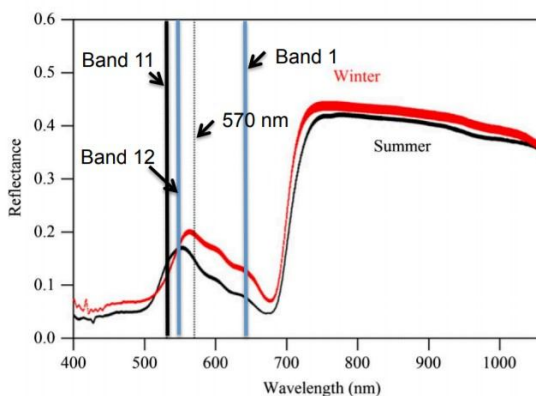
“Invisible” evergreen phenology

CCI

Gamon et al.,
PNAS 2016

Chlorophyll:Carotenoid Index:

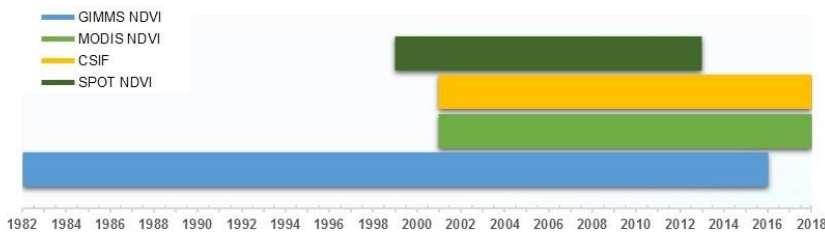
$$CCI = \frac{\text{Band 11} - \text{Band 1}}{\text{Band 11} + \text{Band 1}}$$



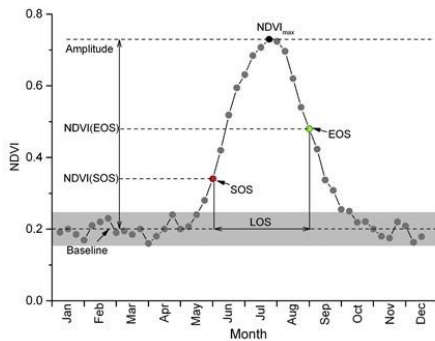
SOS & EOS uncertainty

Extracting the Start/End of Growing Season across the Northern Hemisphere

1 Satellite observation



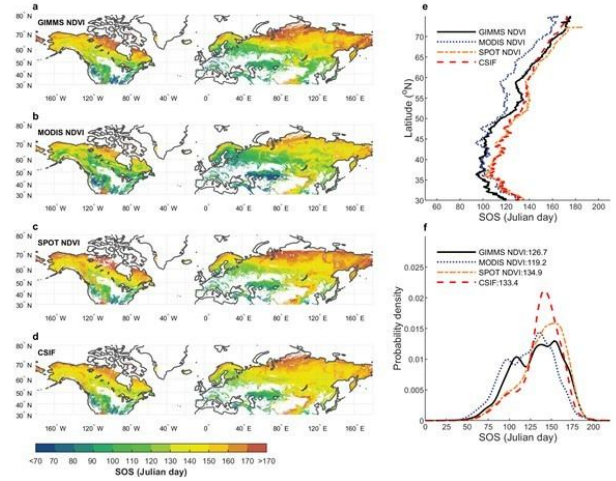
2 Four phenological extraction methods



Step1: data smoothing using filter function (eliminate noise existed in NDVI seasonal curve, convert NDVI data to a daily basis)

Step2: determine the date of Start of growing season (SOS) (using predefined thresholds or changing characteristics of NDVI curve)

3 Intercomparison of satellite-derived SOS



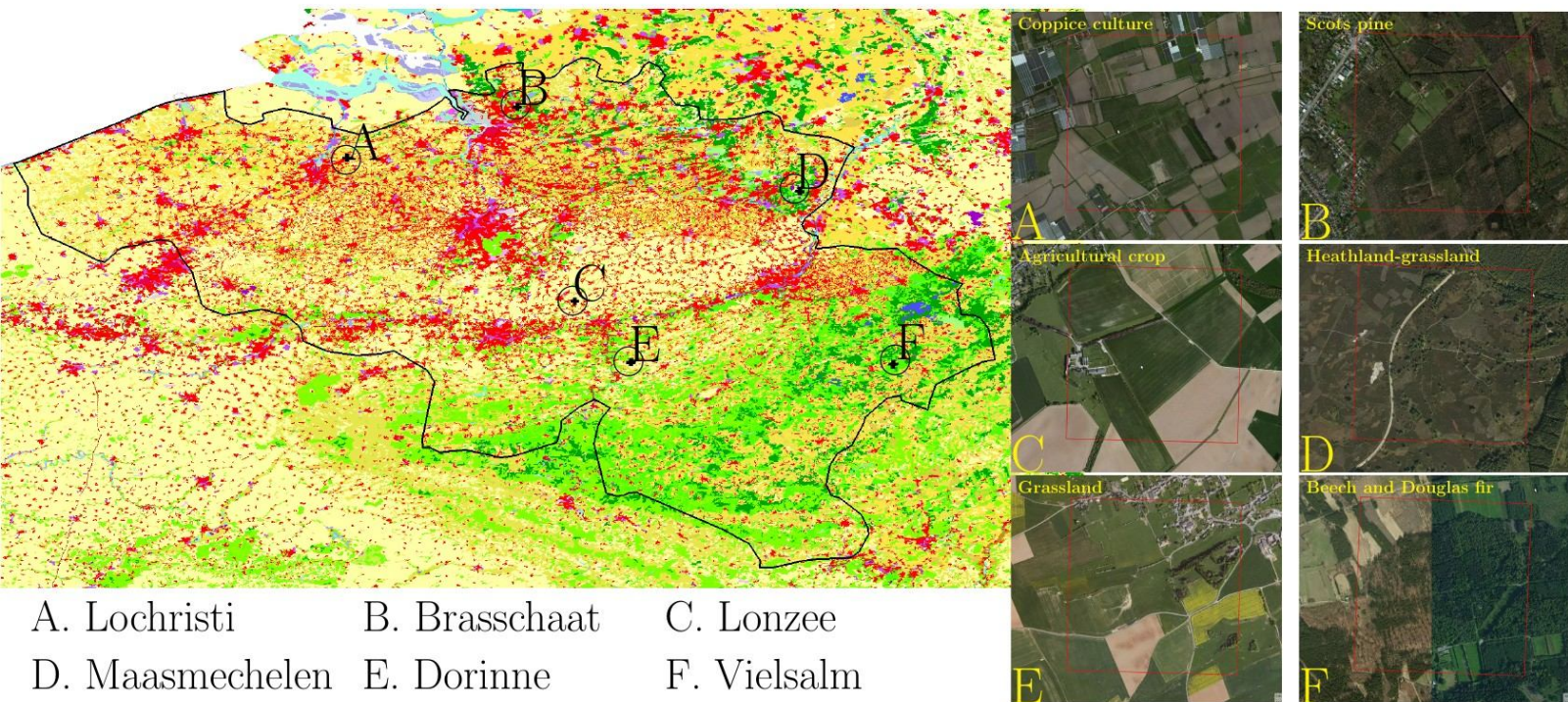
PEKING UNIVERSITY

Prof. Shilong Piao's research group

Alternative RS indicator

Sentinel-2: MTCI, ChlRedEdge, NDVIg, MCARI, PSSR

Belgium (Ongoing), Tropics (Start soon), Europe (Planned)



<http://ecoprophet.meteo.be>

Landscape heterogeneity around ICOS Belgian eddy covariance sites investigated through satellite imagery

ICOS

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1 Background

Terrestrial ecosystems provide food, animal-feed, fibre and energy. Ecosystem production is most important ecosystem service made to society. Important to monitor global ecosystem productivity & build better models.

RS-based models (MODIS) & Land surface models do capture the globe patterns as observed by in-situ observations. Both models depend on observations of surface greenness (NDVI, LAI).

Huge uncertainty in global GPP & NPP estimates.

Most RS-based NPP models fail at reproducing NPP variability. NPP = GPP - Ra or NPP = GPP * (1 - Ra)

2 PROBLEM and study sites

The study was conducted at a large ICOS site. The location of the study site is shown in the map of Figure 1.

3 Methods

The landscape provided clear evidence of the spatial heterogeneity of the study site. The study site was divided into 100m x 100m cells for analysis and each cell was assigned a land use class. This was done using the output of the Night, 8 m, to be used as a reference.

A large number of satellite images were used to investigate the spatial heterogeneity of the study site. The images were processed to extract the vegetation indices (NDVI, LAI) and the land use classes.

4 Preliminary conclusions and Outlook

The analysis of the data and the results of the landscape analysis, demonstrate, that the landscape heterogeneity is a key factor in the study of the landscape heterogeneity. The results of the analysis show that the landscape heterogeneity is a key factor in the study of the landscape heterogeneity.

Acknowledgements

This research was supported by the Flemish Research Foundation for Earth System Science (FLUXUS) and the Ghent University.

ECOPROPHET

Improved Ecosystem Productivity Modeling by Innovative Algorithms and Remotely Sensed PHEnology Indicators

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Overall objective =

improve estimates and projections of GPP & NPP

- NDVI advanced our understanding of global GPP & NPP
- SOC, NDVI & GPP, e.g. boreal forest, senescence in deciduous forests and drought
- Plants invest carbon in nutrient uptake (mycorrhizal symbiosis & exudates). NPP models must take this into account.

Specific objectives

Obj. 1 - Test new RS products (Sentinel, PROSA-V); focus on "functional phenology indicators".

Obj. 2 - New product from CO₂ flux → parameterize phenology products of land surface models → better estimates of GPP, evapotranspiration, energy balance.

Obj. 3 - New product from CO₂ flux → new GPP product, e.g. GPP = f(NPP, Ra) or GPP = f(NPP, Ra, LAI) or GPP = f(NPP, Ra, LAI, PHEnology) or new approaches.

Obj. 4 - Alternative NPP model: NPP = new GPP * NPP/GPP ratio. New GPP from Obj. 2 or 3 (or even NDVI-based GPP). NPP/GPP = function (management & site fertility).

Scientific outcomes

- Identification of RS-based indicators for functional phenology
- Development of GPP & NPP algorithms that are independent from existing algorithms.
- The new RS phenology indicators will help the improvement of land surface models and result in reduced uncertainty in climate projections, thereby allowing better future climate-mitigation policies.

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